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GB 0422772 US 4010964

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G3T
B6A

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(54) Pest control sheet and device for indicating the termination of its effectiveness

(57) An impervious outer package containing a pest control sheet especially for fabric-destructive insects and a device for indicating the termination of the effectiveness of that sheet is provided. The pest control sheet comprises one or more absorbent mats 1—10 mm thick which have been impregnated with a volatile liquid pest control agent and wrapped with an inner package made of a gas-permeable, heat-fusible sheet material, the surface area of the mat or mats being 5 to 60% of the total surface area of said inner package. After heat-sealing the inner package around each mat, the resulting pest control sheet is equipped with the device for indicating the termination of its effectiveness. The assembly is then put into the outer package which is made of a gas-impermeable material such as an aluminum foil, and subsequently sealed airtightly. The pest control sheet is designed for use in cupboards, wardrobes and other enclosed spaces, where after removal of the impervious outer wrapper, it provides an initial rapid dispensing of pest controlling vapour, followed by a slower continuous evolution of vapour.

GB 2 150 834 A

Fig. 1

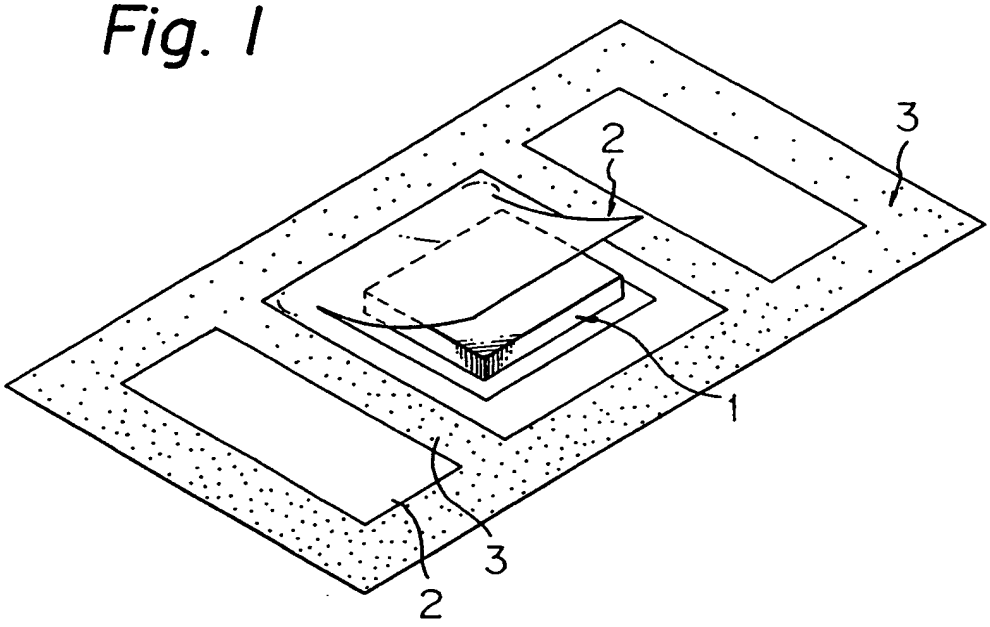

3
2
1
3
2

Fig. 2

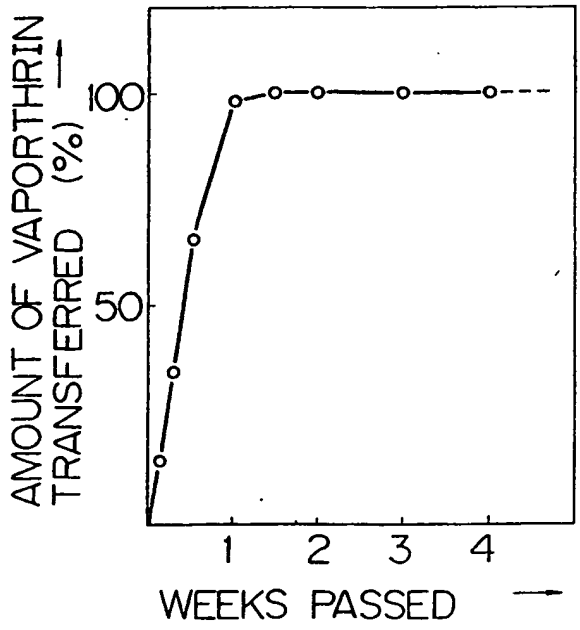

AMOUNT OF VAPORTHRIN TRANSFERRED (%)
100
50
1
2
3
4
WEEKS PASSED

Fig. 3

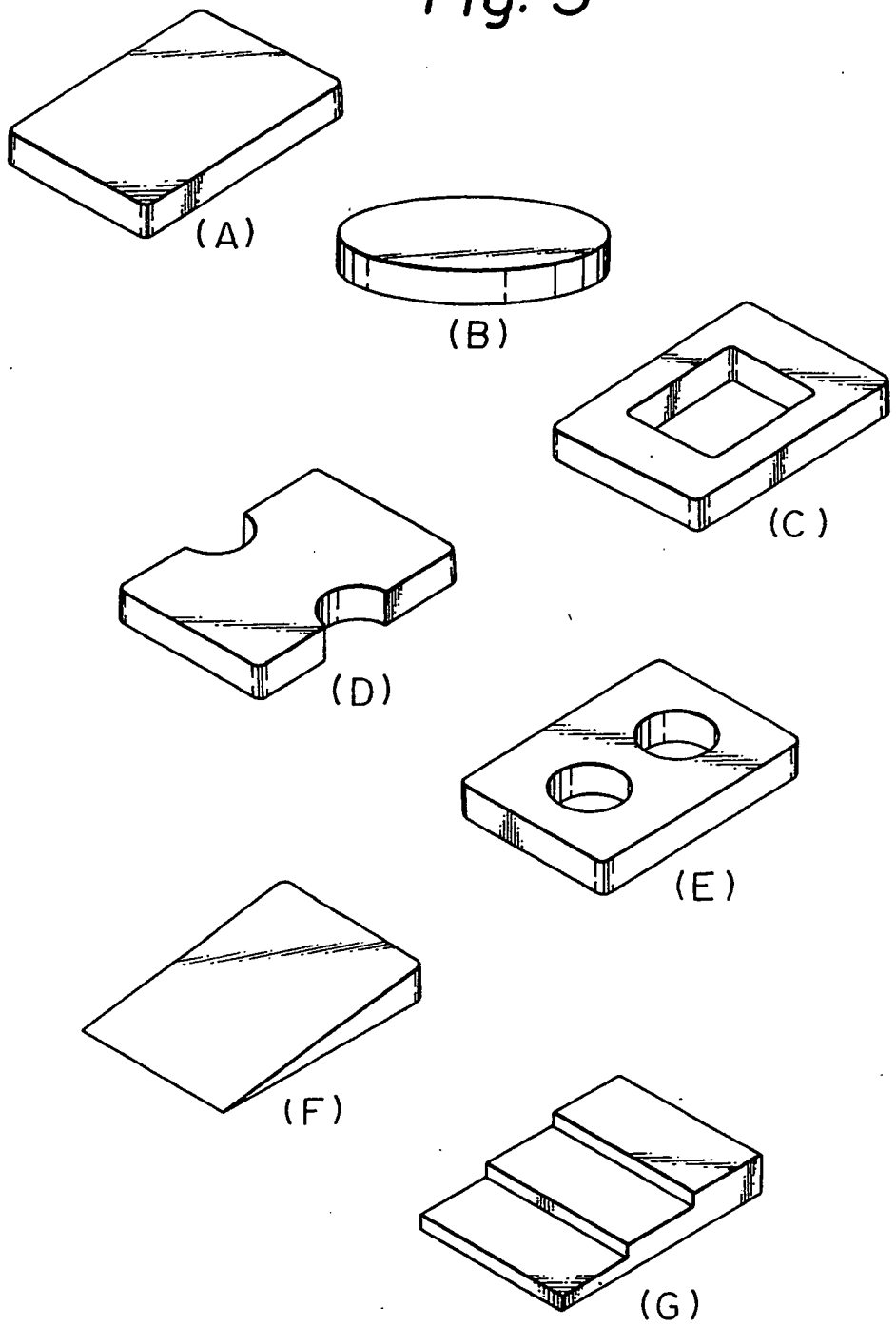


Fig. 4

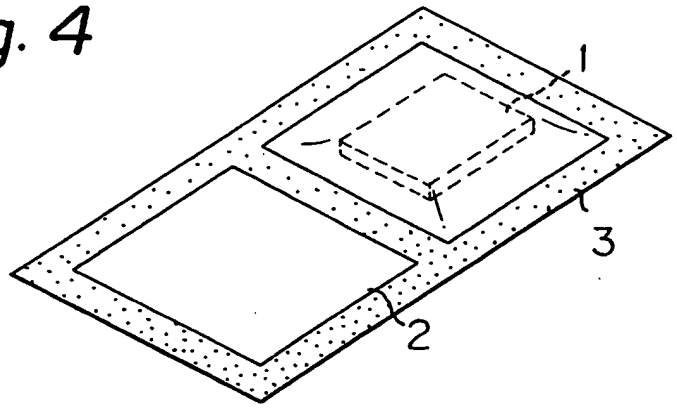


Fig. 5

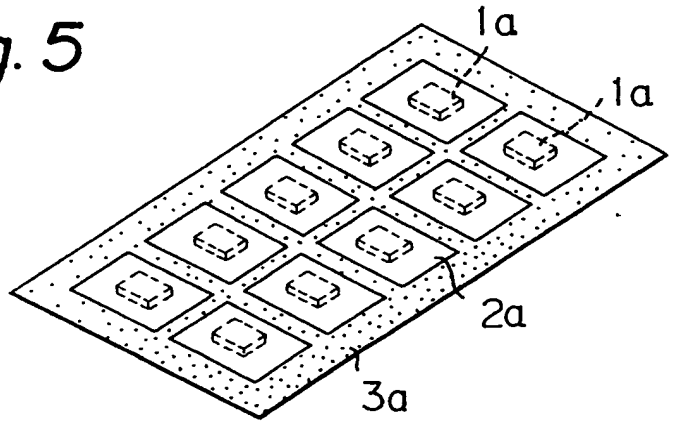


Fig. 6

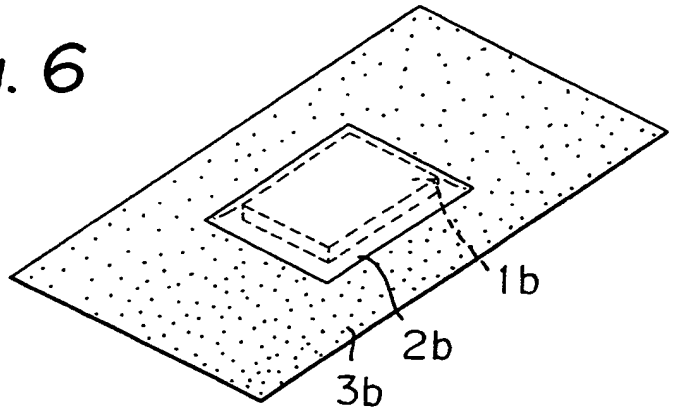


Fig. 7

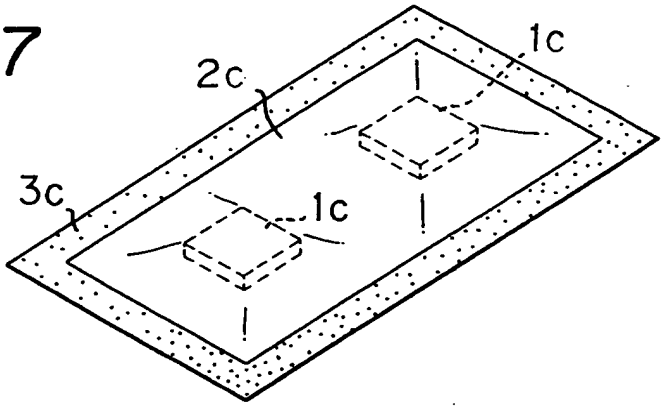


Fig. 8

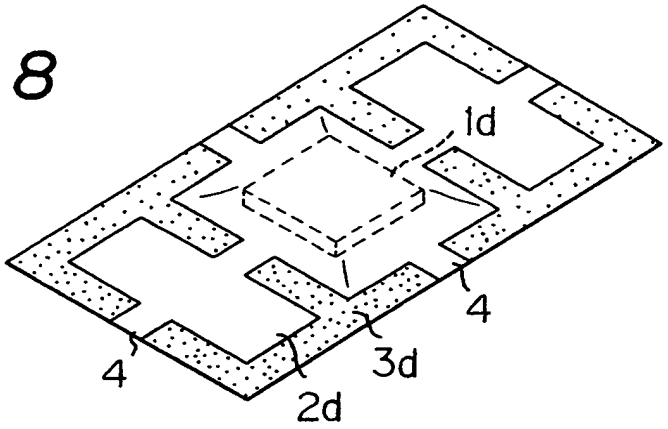


Fig. 9

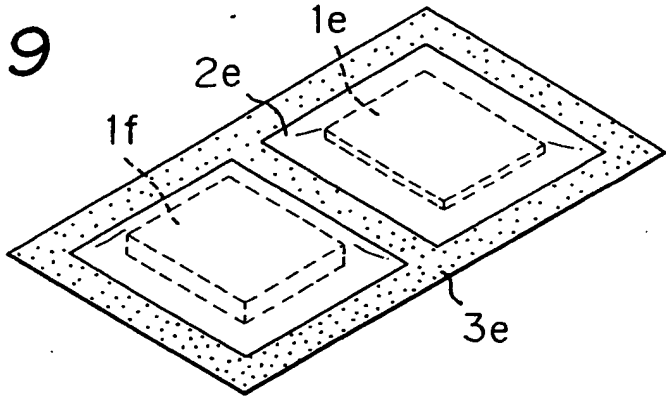


Fig. 10

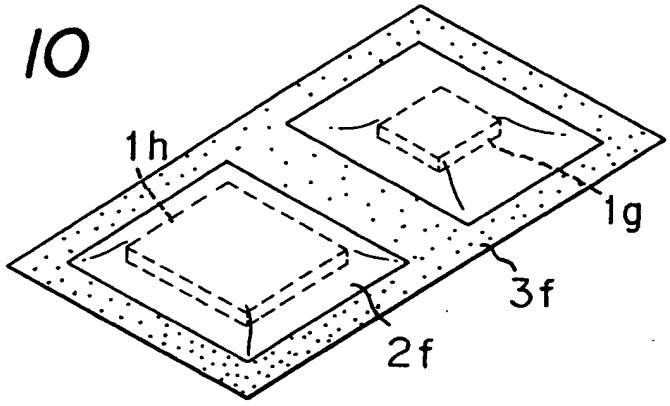


Fig. 11

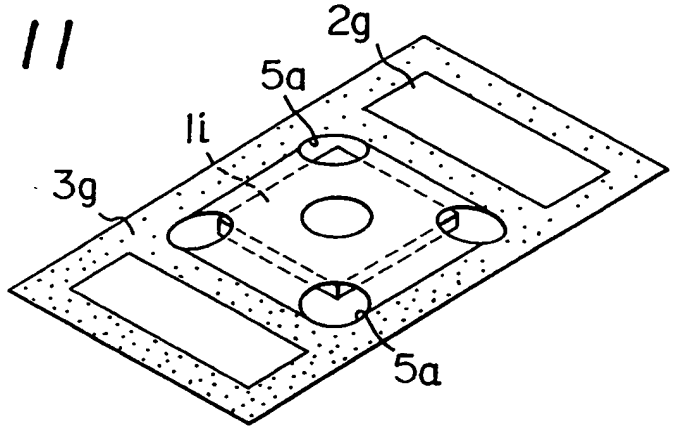


Fig. 12

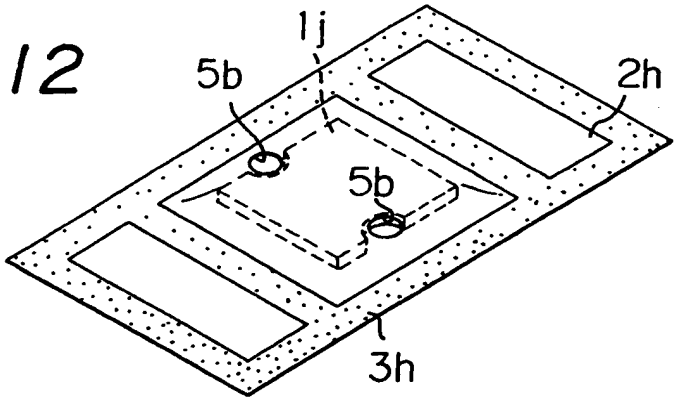


Fig. 13

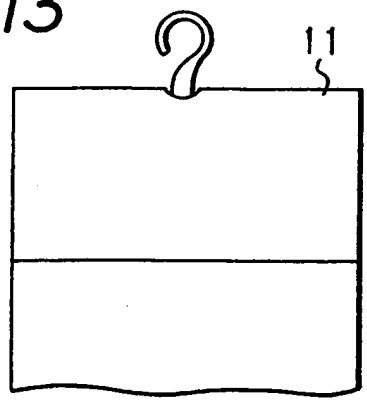


Fig. 14

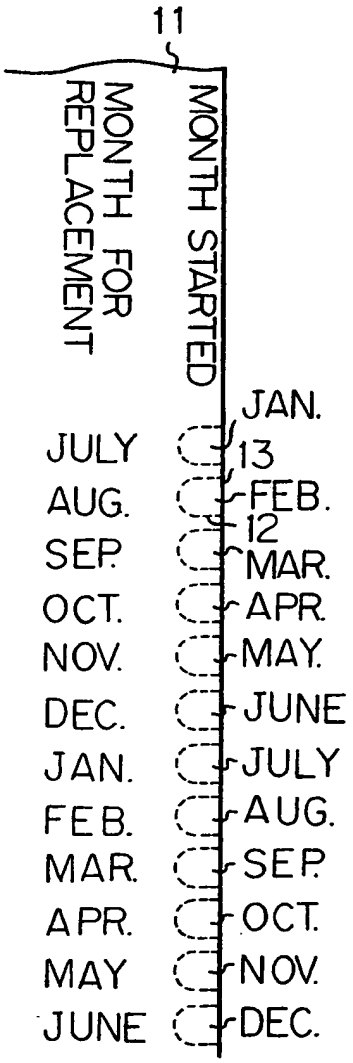


Fig. 15

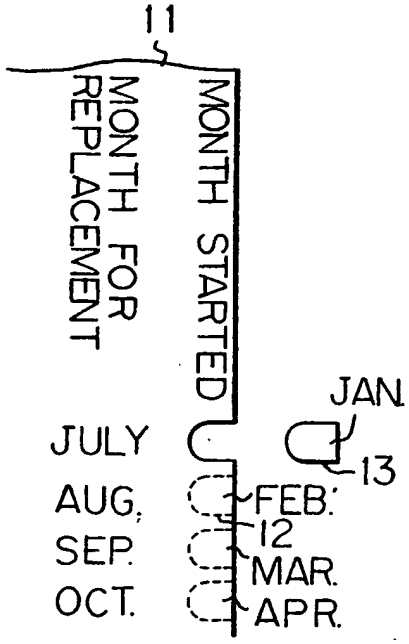


Fig. 16

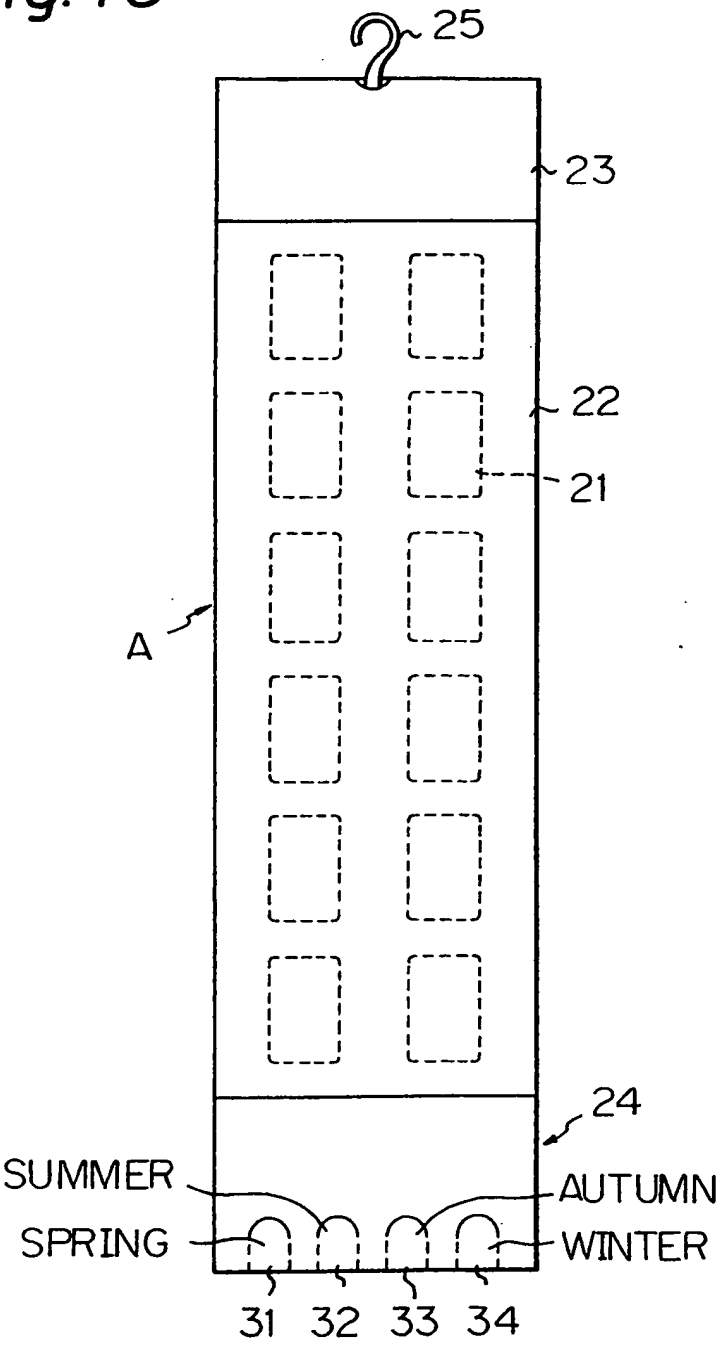


Fig. 17

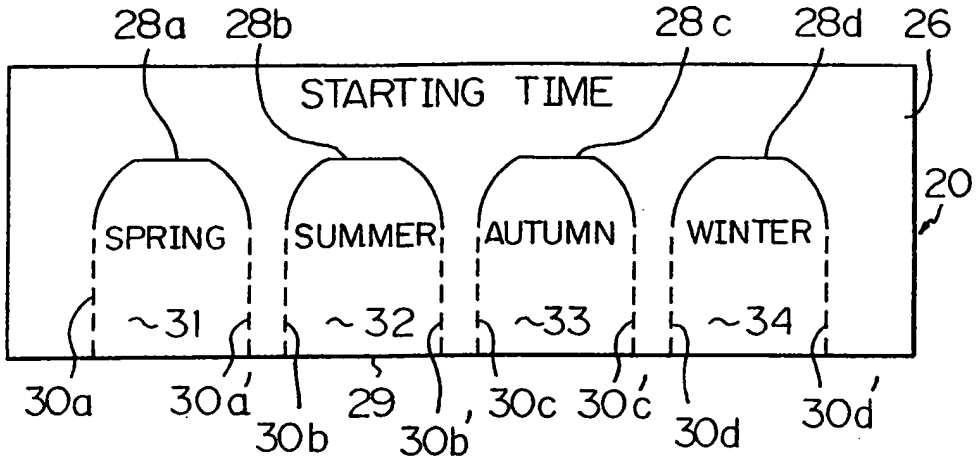

28a
28b
28c
28d
26
STARTING TIME
20
SPRING
SUMMER
AUTUMN
WINTER
~31
~32
~33
~34
30a
30a'
30b
29
30b'
30c
30c'
30d
30d'

Fig. 18

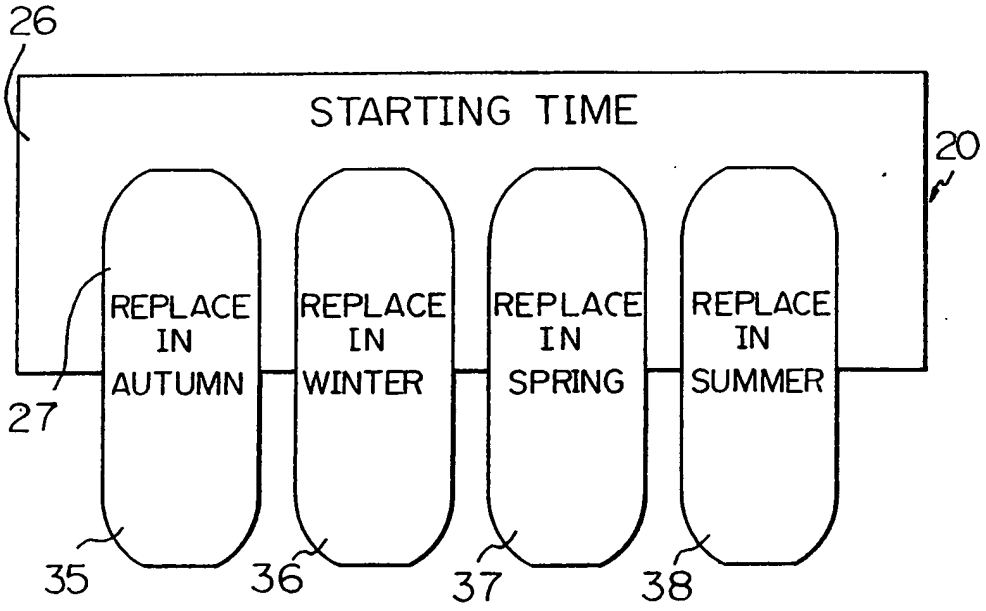

26
STARTING TIME
20
REPLACE IN AUTUMN
REPLACE IN WINTER
REPLACE IN SPRING
REPLACE IN SUMMER
27
35
36
37
38

Fig. 19

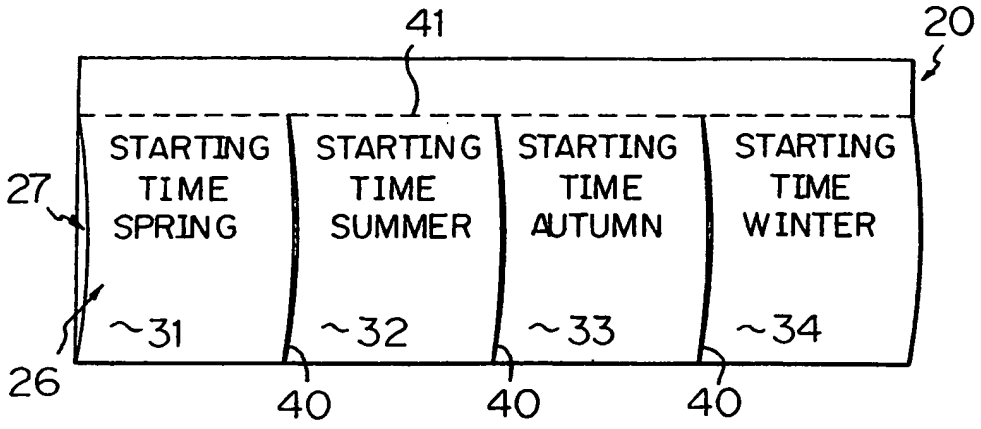

41
20
27
STARTING TIME SPRING
STARTING TIME SUMMER
STARTING TIME AUTUMN
STARTING TIME WINTER
~31
~32
~33
~34
26
40
40
40

Fig. 20

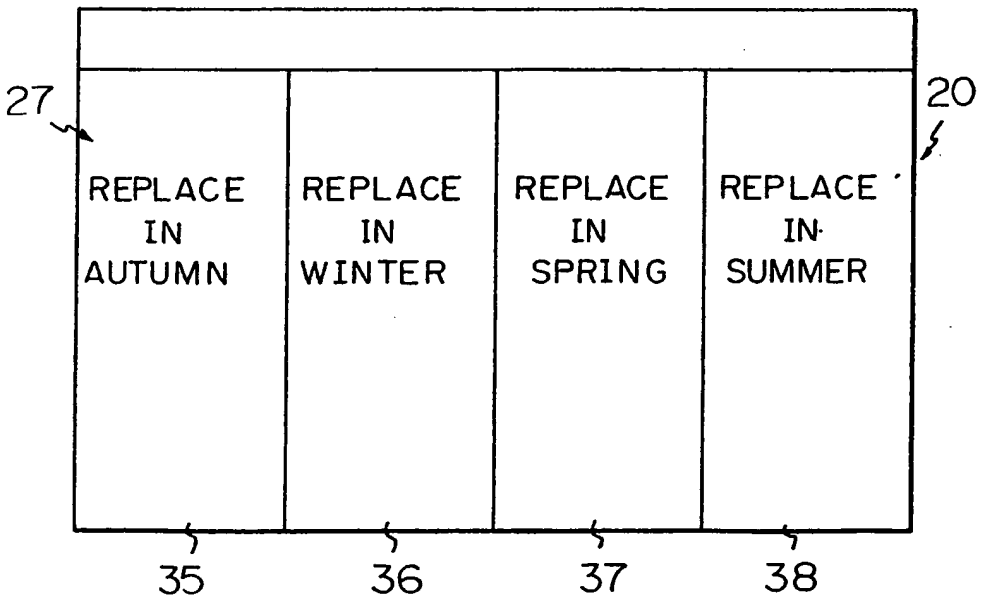

27
20
REPLACE IN AUTUMN
REPLACE IN WINTER
REPLACE IN SPRING
REPLACE IN SUMMER
35
36
37
38

Fig. 21

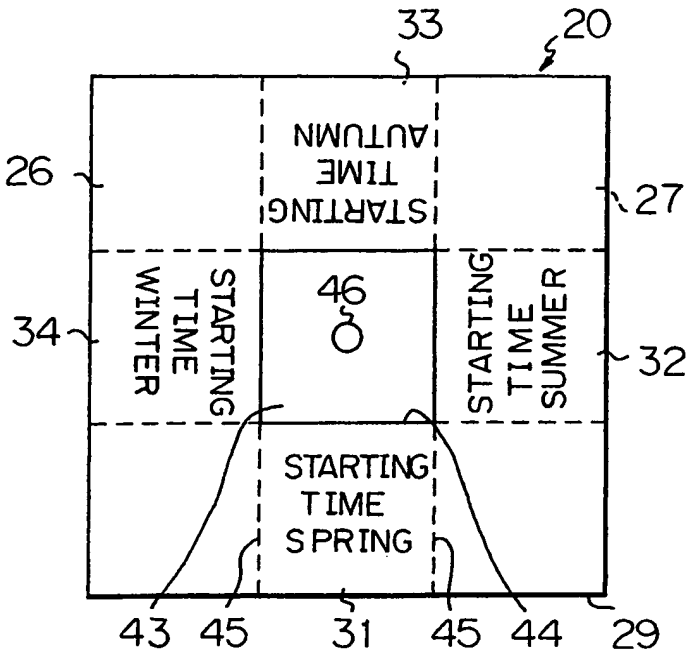

33
20
26
27
34
32
STARTING TIME AUTUMN
STARTING TIME WINTER
46
STARTING TIME SUMMER
STARTING TIME SPRING
43
45
31
45
44
29

Fig. 22

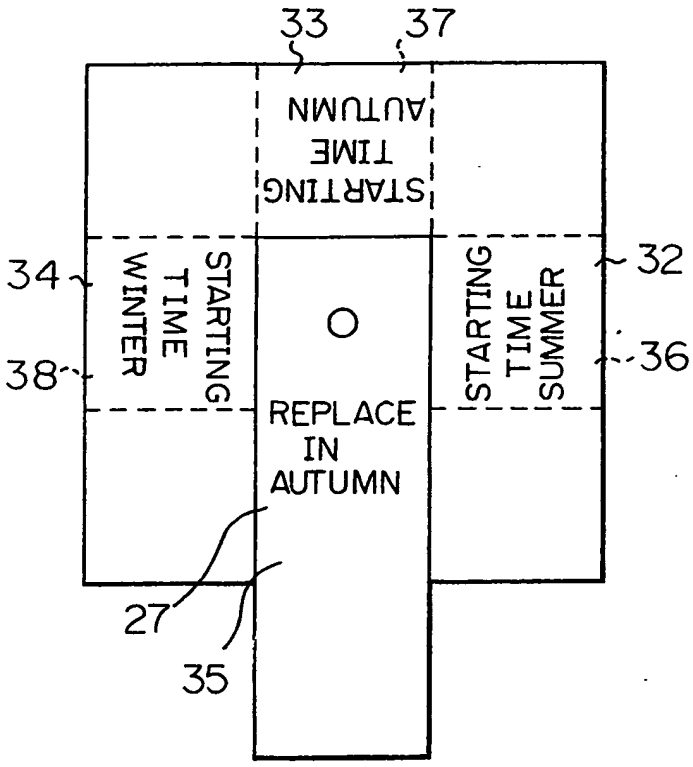

33
37
STARTING TIME AUTUMN
34
32
STARTING TIME WINTER
38
STARTING TIME SUMMER
36
REPLACE IN AUTUMN
27
35

Fig. 23

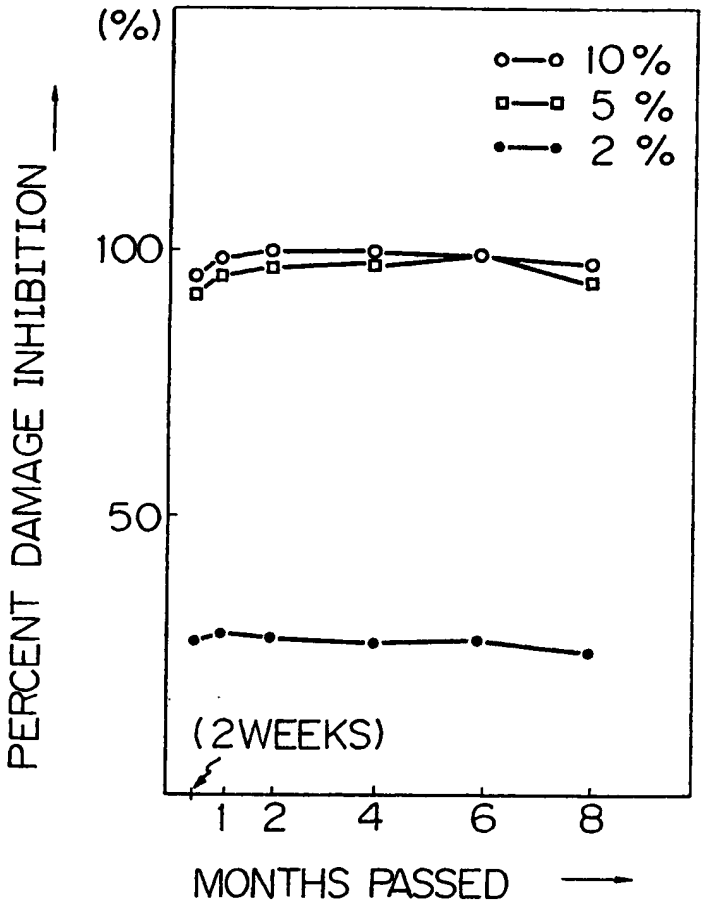

(%)
10%
5 %
2 %
100
50
PERCENT DAMAGE INHIBITION
(2WEEKS)
1 2 4 6 8
MONTHS PASSED

Fig. 24

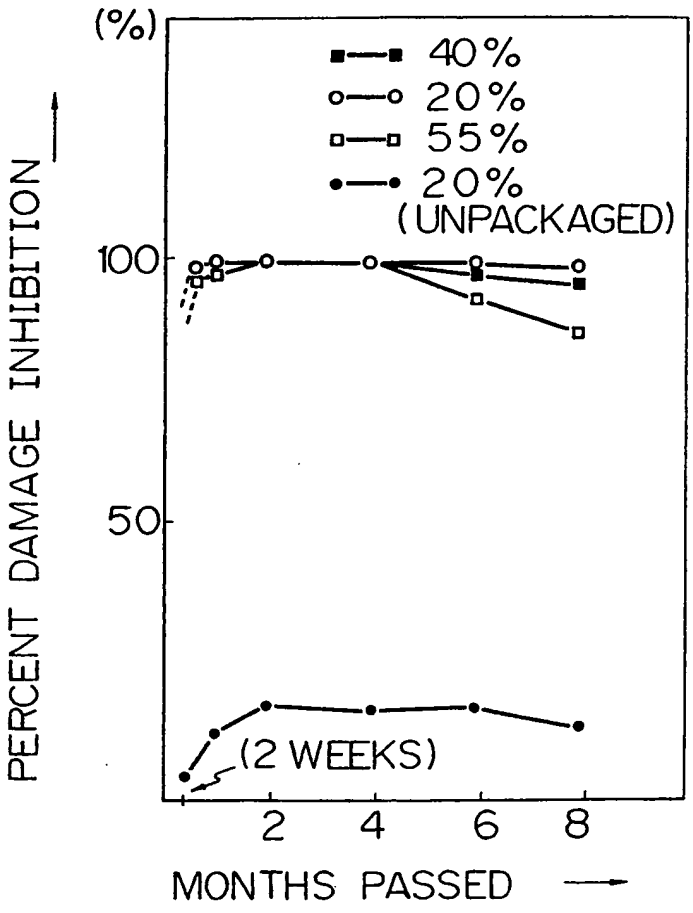

(%)
40%
20%
55%
20%
(UNPACKAGED)
100
50
PERCENT DAMAGE INHIBITION
(2 WEEKS)
2
4
6
8
MONTHS PASSED

Fig. 25

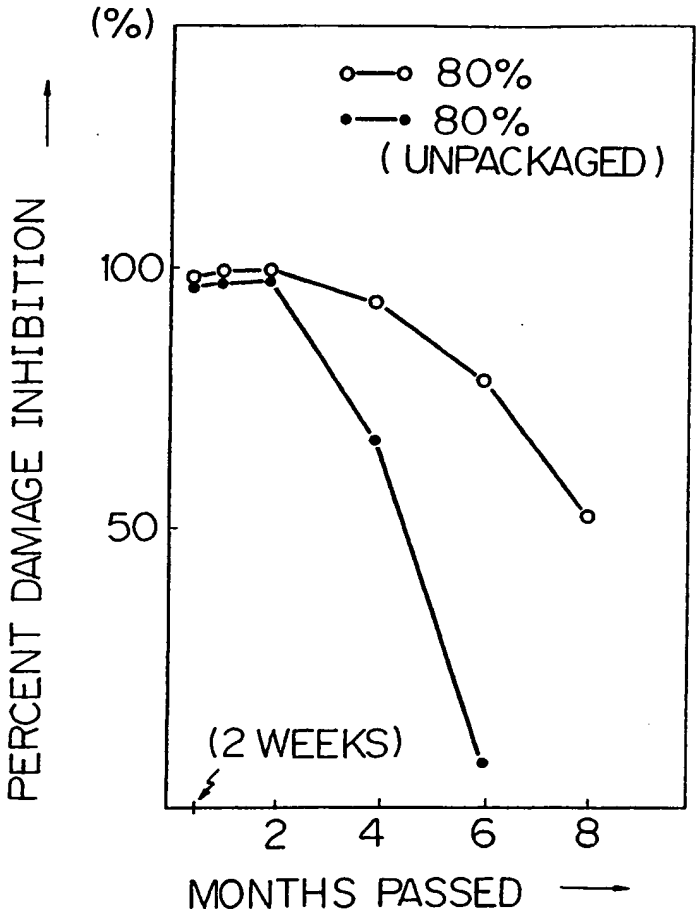

(%)
80%
80%
(UNPACKAGED)
100
50
PERCENT DAMAGE INHIBITION
(2 WEEKS)
2
4
6
8
MONTHS PASSED

Fig. 26

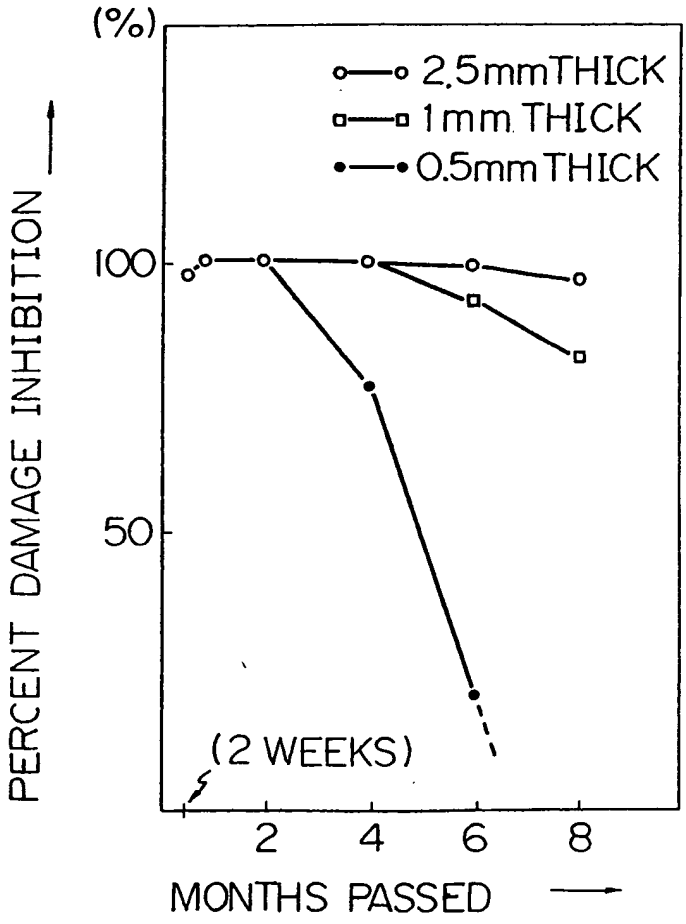

(%)
2.5mmTHICK
1mm THICK
0.5mmTHICK
100
50
PERCENT DAMAGE INHIBITION
(2 WEEKS)
2
4
6
8
MONTHS PASSED

Fig. 27

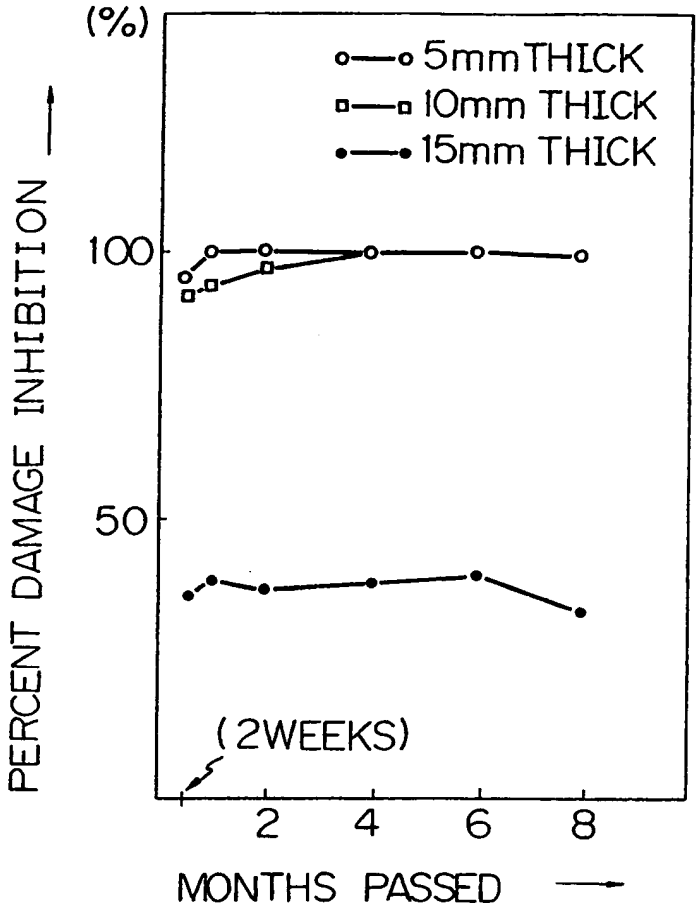

(%)
5mm THICK
10mm THICK
15mm THICK
PERCENT DAMAGE INHIBITION
100
50
(2WEEKS)
2
4
6
8
MONTHS PASSED

Fig. 28

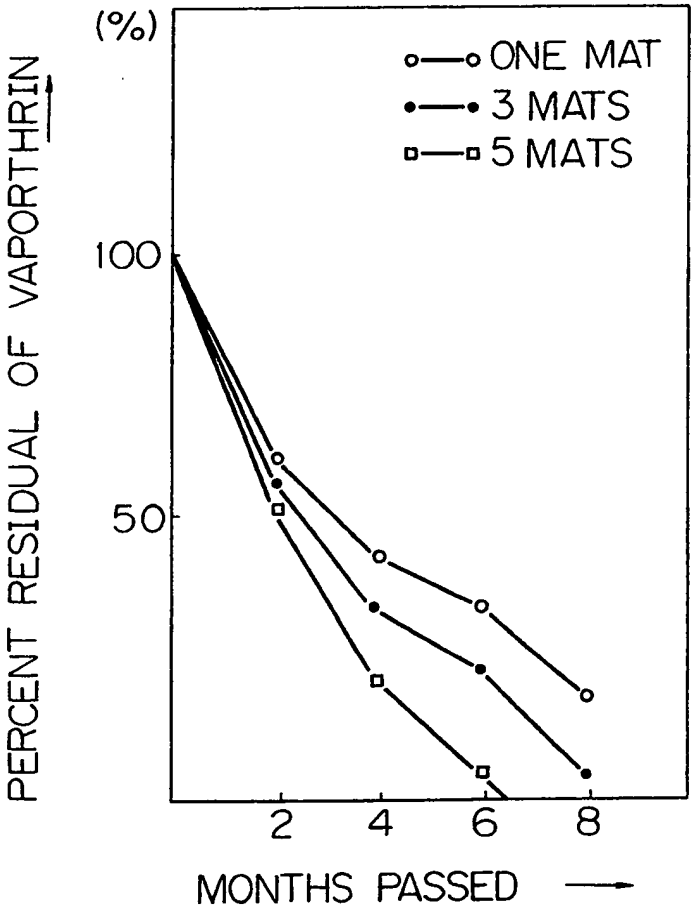

(%)
ONE MAT
3 MATS
5 MATS
100
50
PERCENT RESIDUAL OF VAPORTHRIN
2
4
6
8
MONTHS PASSED

Fig. 29

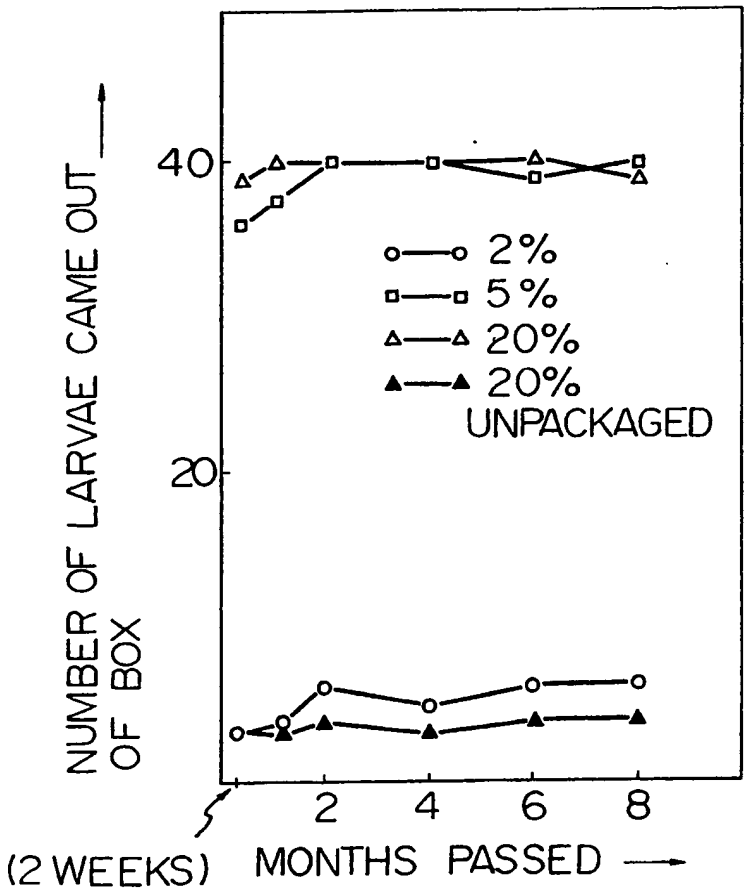

NUMBER OF LARVAE CAME OUT OF BOX
40
20
2%
5%
20%
20%
UNPACKAGED
2
4
6
8
(2 WEEKS)
MONTHS PASSED

Fig. 30

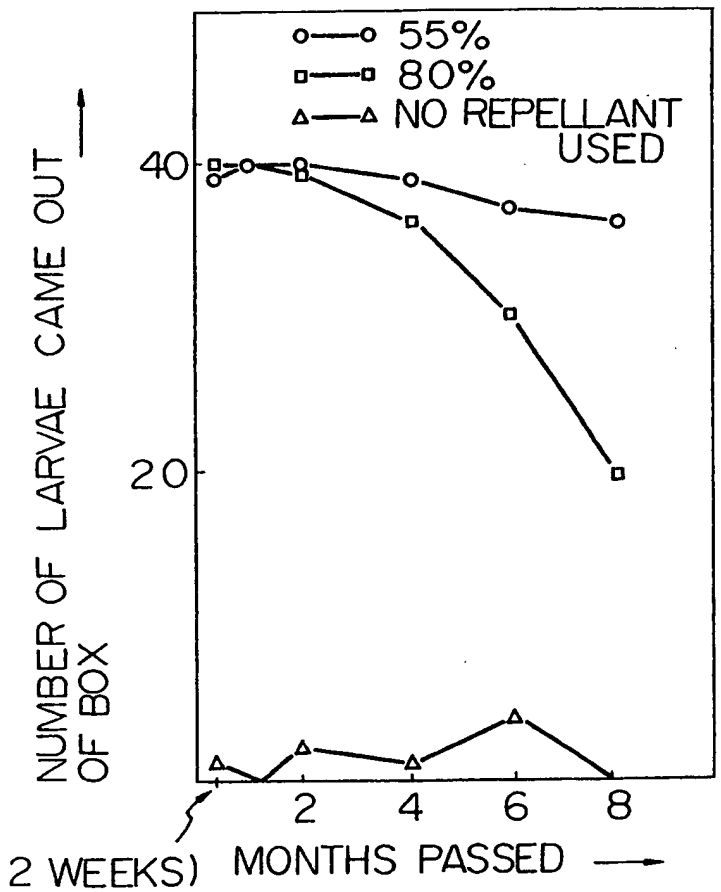

55%
80%
NO REPELLANT USED
40
20
NUMBER OF LARVAE CAME OUT OF BOX
2
4
6
8
2 WEEKS)
MONTHS PASSED

Fig. 31

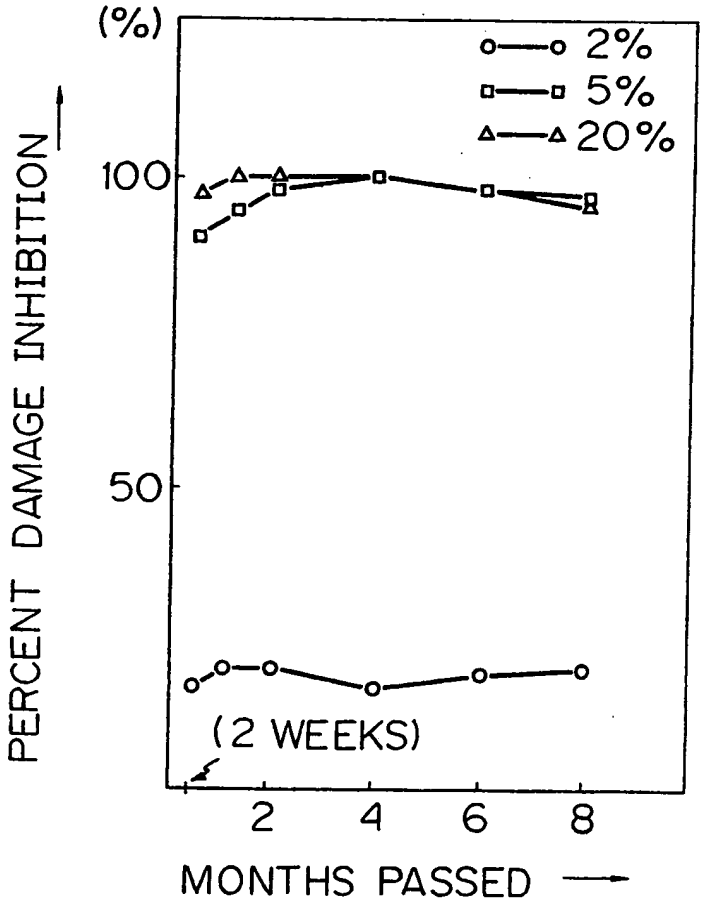
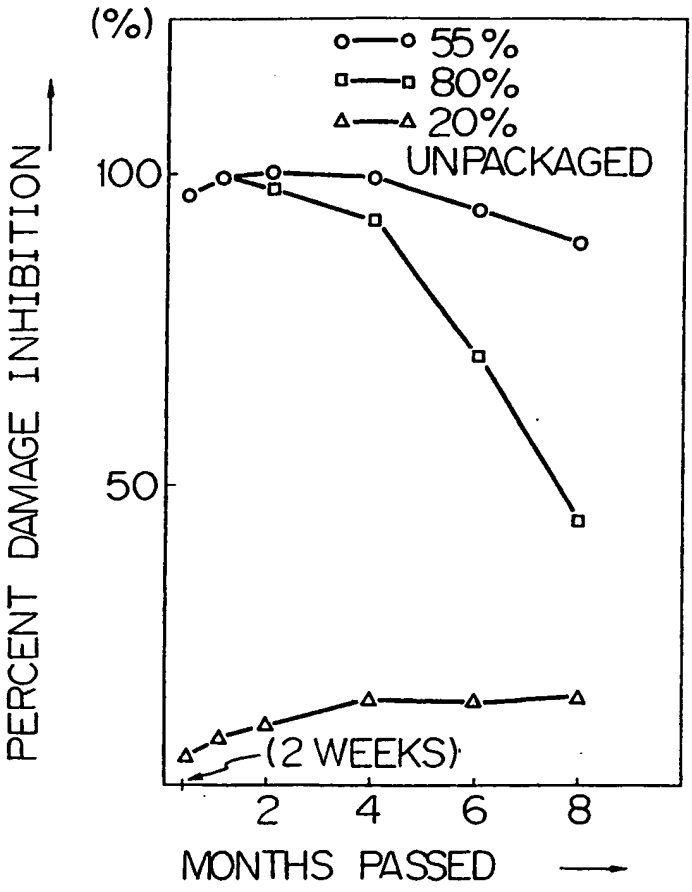

(%)
2%
5%
20%
100
50
PERCENT DAMAGE INHIBITION
(2 WEEKS)
2
4
6
8
MONTHS PASSED

Fig. 32


(%)
55%
80%
20%
UNPACKAGED
100
50
PERCENT DAMAGE INHIBITION
(2 WEEKS)
2
4
6
8
MONTHS PASSED

SPECIFICATION

Pest Control Sheet and Device for Indicating the Termination of its Effectiveness

The present invention relates to a pest control sheet that can be used in wardrobes, closets and any other places. The invention also relates to a device for indicating the termination of the effectiveness of pest control agents and other packaged products of evaporative agents or those which are capable of sublimation such as pest control agents, insecticides, fragrances, deodorants, repellants, attractants and bactericides.

Conventionally, there are two types of agents (including pesticides, moth proofing fragrances and repellants) used to control pests, particularly fabric pests. The first type of agents are those which are solid and are capable of sublimation such as paradichlorobenzene, naphthalene and camphor, and the second types of agents are evaporative liquids such as organophosphorus compounds (e.g. DDVP, and Sumithion by Sumitomo Chemical Co. Ltd.) and synthetic pyrethroids such as 1-ethynyl-2-methyl-2-pentenyl-2,2-dimethyl-3-(2',2'-dichlorovinyl)-cyclopropane-1-carboxylate, 1-ethynyl-2-methyl-2-pentenyl-2,2-dimethyl-3-(2'-methyl-1'-propenyl)-cyclopropane-1-carboxylate and 1-ethynyl-2-methyl-2-pentenyl-2,2,3,3-tetramethylcyclopropane carboxylate.

The solid pest control agents which are capable of sublimation are used by being placed in plastic containers or packaged with Japanese paper or nonwoven fabrics. The purpose of packaging with Japanese paper or nonwoven fabrics is to prevent the two major defects with the solid type pest control agent, i.e. loss of its effectiveness by sublimation in a short period, and fouling of fabrics or clothes due to contact with the agent. By wrapping with Japanese paper or nonwoven fabrics, the sublimation of the pest control agent is minimized so as to prolong the effective period of the agent, and direct contact with fabrics or clothes is prevented to avoid its fouling.

The liquid type pest control agent is impregnated in paper, plastics or porous materials and used either immediately or after being put in a plastic container. No detailed studies have been made on the possibility of packaging this liquid type of pest control with Japanese paper or nonwoven fabrics. The efficacy of most liquid type agents is greater than that of the solid type agent and only a small amount of the agent is necessary for exhibiting its intended effect. However, the vapor pressure of the liquid type agent is lower than that of the solid type and the amount of evaporation in the initial period of use is too small to exhibit a high insecticidal effect. Therefore, there is no need at all for inhibiting the evaporation of the liquid type pest control agent by wrapping it with Japanese paper or nonwoven fabrics; on the contrary, some method must be used to enhance its evaporation.

In order to ensure a high control efficacy from the start of use, researchers have made various attempts to increase the area of evaporation by using a complexly shaped substrate impregnated with the effective ingredient, or to provide increased evaporation by decreasing the thickness of the substrate to be impregnated. These methods are effective for letting the agent exhibit its efficacy from the start of use, and when a certain period has elapsed, the concentration of the active ingredient on the site of use has reached its effective level and thereafter, only the amount of the agent that makes up for the loss of the active compound due to decomposition or leakage from the site of use need be evaporated. However, in the absence of a provision that takes this situation into consideration, the conventional pest control agent of the liquid type lets the active compound evaporate continuously in a large amount and the effectiveness of the agent is lost in a very short period of time. Furthermore, the amount of evaporation of the active component varies with environmental conditions such as temperature, humidity and wind.

If, in order to extend the effective period, the size of the substrate to be impregnated with the agent is restricted, the insufficiency of the area of evaporation allows only a small amount of the agent to evaporate. As a result, the efficacy of the agent is reduced not only in the initial period of use but also in the later stage.

The above-mentioned problems are inherent in the nature of the substrate which serves both as a holder and feeder for the pest control agent and as its evaporator. In order to ensure a sufficient efficacy not only in the initial period of use but also in the subsequent period, the substrate must be made of a porous material and have large dimensions. However, the substrate then has a small ability to retain the effective ingredient, whereas its supply becomes excessive, with the result that the effectiveness of the agent is lost within a very short period. On the other hand, in order to retain the efficacy over an extended period, the substrate must be made of a dense composition that strongly retains the effective component and prevents its excessive supply. Furthermore, the evaporation area of the substrate must be decreased.

As shown above, in order to ensure a sufficient evaporation of the efficacious component from the beginning of use and to maintain the necessary evaporation over a prolonged period, a compromise must be made with respect to the material, size and shape of the substrate to be impregnated by a liquid pest control agent. The impregnated substrate is used either directly or after being packaged in a plastic container.

Devices are available for indicating the termination of the effectiveness of pest control agent and other evaporative agents such as those wrapped with sheet or other suitable packaging materials. An example is known for use with a pest control sheet that is suspended between clothes in a wardrobe. This device consists of twelve perforated portions provided on one lateral edge of the sheet (indicating Month Started by a series of months starting with January and ending with December) and an adjacent column of months starting with July and ending with June for indicating Month for Replacement. When the sheet is first used

in January, the user detaches the perforated portion marked "January" and recognizes that he has to replace the sheet in July. However, with this conventional device marked with two parallel adjacent columns of "Month Started" and "Month for Replacement" on the same side of the sheet, the user often reads a month wrongly or finds considerable difficulty in understanding how to use that device. Furthermore, if the user detaches a perforated portion wrongly, he is no longer able to replace it. Another defect is that the perforated portions are too small to handle conveniently.

Therefore, one object of the present invention is to provide a pest control sheet using a liquid active ingredient that exhibits a sufficient efficacy from the start of its use and ensures the necessary efficacy over an extended period, and which is easy to use and manufacture.

Another object of the present invention is to provide a device for indicating the termination of the effectiveness of pest control agents and other packaged products of evaporative agents or those capable of sublimation such as pest control agents, insecticides, fragrances, deodorants, repellants, attractants and bactericides. The device requires a simple step to provide visual checking of the replacement time and permits easy repair of an erroneously exposed indicating section.

The pest control sheet of the present invention is based on our understanding that it is impossible for one and the same impregnated substrate to exhibit a sufficient evaporation of the effective ingredient from the start of use and yet to maintain the properly controlled evaporation at subsequent stages. Therefore, according to the present invention, the substrate is divided into two portions, one being a holder and feeder of the pest control agent and the other being its evaporator. In the first stage of use, the evaporator enables rapid evaporation of the necessary amount of the effective ingredient. In the subsequent stage, the holder and feeder supplies the necessary amount of active ingredient to the evaporator at a suitable rate.

We have made a series of experiments using this dual structure substrate and have found the following: when a small element impregnated with a liquid pest control agent is left to stand for a certain period (e.g. ca. one week) as it is, in contact with or wrapped by Japanese paper or any suitable material, more of the active component has evaporated from the Japanese paper or the like than from the initially impregnated element. The evaporation from the Japanese paper or the like increases as its size is increased.

This phenomenon is not observed when a solid pest control agent capable of sublimation such as paradichlorobenzene is wrapped with Japanese paper or any other suitable material, and hence this is considered to be unique to the liquid pest control agent. The purpose of wrapping a solid pest control agent with Japanese paper or the like is to inhibit, rather than promote, the evaporation of the agent.

On the basis of this interesting phenomenon, we continued our studies and found that when a carrier element impregnated with a liquid pest control agent is wrapped with a package of a larger size made of, for example, Japanese paper, a given amount of the agent first penetrates into the Japanese paper from which it evaporates, and the resulting loss in the agent is compensated by a continued supply from the carrier element or substrate. This advantage of the pest control sheet of the present invention is achieved only when the surface area of the carrier element satisfies a specific relation with the total surface area of the inner package (made of, for example, Japanese paper) which is in contact with the carrier member.

Therefore, according to one aspect of the present invention, there is provided a pest control sheet which consists of a carrier element, 1—10 mm thick, which has been impregnated with a pest control agent (inclusive of an insecticide, a moth proofing fragrance and a repellant) and is wrapped with an inner package of an air-permeable sheet material such as Japanese paper, nonwoven fabric, cloth or paper in such a manner that the surface area of said carrier element accounts for 5—60% of the total surface area of the inner package. This pest control sheet exhibits a sufficient efficacy from the beginning of use and maintains the necessary effectiveness over an extended period. Another aspect of the present invention is to provide a pest control product having this sheet packed and sealed air-tightly in a gas-permeable container. According to a further aspect of the present invention, there is provided a device for indicating the termination of the effectiveness of a packaged pest control agent, any other evaporative chemical agent or packaged agents capable of sublimation, said device consisting of a sheet member having at least one section indicating a specific replacement time, said sheet being folded up to conceal said indicating section and to form an inner layer of the sheet portion having said indicating section, that part of the outer layer of said sheet member which corresponds to said indicating section being peelable above the fold line, said peelable portion being marked with letters representing the "starting time".

Fig. 1 is a perspective view of the pest control sheet according to one embodiment of the present invention;

Fig. 2 is a graph showing the time profile of penetration of the effective ingredient into an inner package;

Figs. 3(A) to 3(G) are perspective views showing various shapes of a substrate;

Figs. 4 to 12 are perspective views showing various forms of the inner package and manners in which it is sealed;

Fig. 13 is a front view of the conventional pest control sheet;

Fig. 14 is an illustration of the conventional device for indicating the termination of the effectiveness of a pest control agent;

Fig. 15 shows how the device of Fig. 14 is used;

Fig. 16 is a front view of the pest control sheet equipped with the device for indicating the termination of its effectiveness according to one embodiment of the present invention;

Fig. 17 is a front view of the device of Fig. 16 with none of the concealed sections for indicating replacement times being exposed;

Fig. 18 is a front view of the device of Fig. 16 with all of the concealed sections for indicating replacement times being exposed;

Fig. 19 is a front view of the device according to another embodiment of the invention, with none of the concealed sections for indicating replacement times being exposed;

Fig. 20 is a front view of the same device with all of the concealed sections for indicating replacement times being exposed;

Fig. 21 is a front view of the device according to a further embodiment of the invention, with none of the concealed sections for indicating replacement times being exposed;

Fig. 22 is a front view of the same device with one of the concealed sections for indicating replacement times being exposed;

Figs. 23 to 27 are graphs showing the time-dependent change of the percent damage inhibition by various types of pest control sheet;

Fig. 28 is a graph showing the time-dependent change of the residual effective ingredient in the substrate as against the pest control sheet;

Figs. 29 and 30 are graphs showing the time-dependent change of the number of larvae that came out of the box; and

Figs. 31 and 32 are graphs showing the time-dependent change of the percent damage inhibition by other types of pest control sheet.

Various embodiments of the pest control sheet according to one aspect of the present invention are hereunder described.

The substrate to be impregnated by the liquid pest control agent is made of a material selected from among natural fibers such as cotton and wool, synthetic fibers such as nylon fibers and polyester fibers, inorganic fibers such as glass fibers, carbon fibers and asbestos, inorganic porous materials such as silica gel and alumina, plastics such as polyethylene, a copolymer of ethylene and vinyl acetate, and polyvinyl chloride, gelling agents such as agar-agar and gelatin, and compounds, such as cyclodextrin and zeolites, which are capable of including a liquid pest control agent. These materials may be used either independently or in combination. They may be used in any suitable forms such as paper, film, sheet, mat and shaped plates. Paper and mats are preferred. The substrate may be replaced by a microencapsulated liquid pest control agent. The substrate used in the present invention may also contain other pest control agents, insecticides, perfumes, mold inhibitors, synergists, bactericides and desiccants. Alternatively, the substrate impregnated with the liquid pest control agent may be placed within one and the same inner package together with another substrate impregnated with these co-ingredients.

In the present invention, the term "a liquid pest control agent" also includes a liquid insecticide, a liquid repellant and a liquid moth proofing fragrance. The preferred examples of the liquid insecticide are 1-ethynyl-2-methyl-2-pentanyl-2,2-dimethyl-3-(2',2'-dichlorovinyl)-cyclopropane-1-carboxylate, 1-ethynyl-2-methyl-2-pentenyl-2,2-dimethyl-3-(2'-methyl-1'-propenyl)-cyclopropane-1-carboxylate and 1-ethynyl-2-methyl-2-pentenyl-2,2,3,3-tetramethylcyclopropane carboxylate. The preferred examples of the liquid repellant are N,N-diethyl-m-toluamide, 2,3,4,5-bis(2-butylene)-tetrahydrofurfural, di-n-propyl isocinchomeronate and dibutyl phthalate. The preferred examples of the liquid moth proofing fragrance are citronellol, eugenol and isosafrol.

The thickness of the substrate ranges from 1 to 10 mm, preferably from 2 to 10 mm. The number of the substrates to be accommodated in one inner package is not limited to any particular value. A plurality of substrates may be put in the inner package in such a manner that their surface area is not more than 60% preferably from 5 to 40%, of the total surface area of the inner package. Needless to say, this range should be met by the surface area of the substrates, taken altogether not individually. The total surface area of the inner package means the area of the exterior surfaces of the top and bottom sheets but does not include the area of their inner surfaces. This definition applies both to sealed and unsealed portions of the inner package. In the absence of a sealed portion along lateral sides, the inner surfaces of the package will be brought into contact with atmospheric air, but even in this case, the area of these inner surfaces is not counted in as the surface area of the inner package. The criticality of limiting the surface area of the substrate to a value not more than 60% of the total surface area of the inner package will become apparent by reading the Examples which are given later in this specification.

The inner package which accommodates the substrate may be made of any gas-permeable sheet material that is capable of impregnation with the effective ingredient and which permits its rapid evaporation. In other words, the material for the inner package must be not only gas-permeable but also be capable of rapid desorption of the effective ingredient. Suitable examples of such material are Japanese paper, nonwoven fabrics, cloth, and ordinary papers such as kraft paper. These sheet materials may be treated with heat-fusible resins; for example, gas-permeable materials such as paper and nonwoven fabrics may be mixed with a powder or fibers of a heat-fusible resin during their production. Sheet materials furnished with heat fusibility are also included in the scope of the sheet material for making the inner package. Heat-sealable Japanese paper and nonwoven fabrics are preferred.

The pest control sheet comprising the substrate (impregnated with the effective ingredient) put in the inner package is sold on the market after being sealed with an outer package made of a gas-impermeable sheet material such as an aluminum foil, a laminate having an aluminum layer or a plastic sheet deposited with aluminum. While this form of package is preferred, the pest control sheet may also be sealed in another type of container such as a plastic can. The control sheet is stored in this outer package or container until use, when the sheet is taken out of the outer package or container and positioned in a desired place.

The pest control sheet of the present invention is hereunder described in detail by reference to the specific embodiments shown in accompanying drawings.

Fig. 1 shows the pest control sheet according to the one embodiment of the invention. A small mat or substrate 1 impregnated with a liquid pest control agent or a suitable effective ingredient is placed between two sheets of paper 2 that is made of gas-permeable material such as Japanese paper or nonwoven fabrics and which is treated with a resin so as to render the paper heat-sealable. The sheets of paper 2 are then heat-sealed (as indicated by numeral 3) on the four sides and in the area that surrounds the mat 1. For the purpose of clarity, the inner package 2 of the mat 1 is shown partially open in Fig. 1, but it should be understood that the inner package actually forms a continuous surface.

With the packaged pest control sheet shown in Fig. 1, the pest control agent impregnated in the mat 1 having a small surface area and which is placed in contact with the inner package 2 transfers into the package 2. In other words, the inner package 2 serves not only as the package of the mat 1 but also as the second element to be impregnated with the effective ingredient. However, the package 2 which is made of thin sheets of Japanese paper or nonwven fabrics has a limited ability to retain the liquid effective ingredient (this ability also depends on the amount of the effective ingredient contained in the mat 1 or the supplier of the effective component). Therefore, the transfer of the effective ingredient into the inner package is terminated or suppressed when the agent contained in the inner package reaches a predetermined equilibrium state. Thereafter, the effective component that has been transferred into the inner package 2 evaporates from its surface. The resulting loss in the amount of the effective ingredient is compensated by an additional supply from the mat 1, thus ensuring the continued evaporation of the effective ingredient.

The time profile of the transfer of the pest control agent (or its effective ingredient) into the inner package is depicted in Fig. 2, which is a graph showing the amount of (R,S)-1-ethynyl-2-methylpent-2-enyl(1R)-cis,transchrysanthemate (hereunder referred to as Vaporthrin, a trade name for this particular compound available from Sumitomo Chemical Co., Ltd.) transferred from the mat 1 into Japanese paper or nonwoven fabric, with the final equilibrium state of the distribution of the effective ingredient in the Japanese paper or nonwoven fabric being taken as 100%. As is clear from Fig. 2, the amount of the effective ingredient in the Japanese paper or nonwoven fabric in contact with the mat 1 reached a substantial equilibrium state within a week, indicating a rapid transfer of the agent into the Japanese paper or nonwoven fabrics.

Various shapes of the mat 1 are shown in Figs. 3(A) to 3(G). The mat may be rectangular [Fig. 3(A)] or circular [Fig. 3(B)] or may assume any other shape which is not shown in Fig. 3. The mat may be provided with a rectangular hole that is punched out in the center as shown in Fig. 3(C); it may be notched at two side edges as shown in Fig. 3(D); or it may be provided with two circular through-holes as shown in Fig. 3(E). The thickness of the mat may be changed gradually [Fig. 3(F)] or stepwise [Fig. 3(G)]. By properly selecting one of these configurations, the amount of evaporation of the effective ingredient, namely its effective period, can be controlled.

Various manners of accommodating the mat in the inner package and of sealing the latter are shown in Figs. 4 to 12. It should be understood that the embodiments of these Figures are given for illustrative purposes only and should by no means be taken as limiting examples. As already shown in Fig. 1, the mat 1 may be placed in the center of the inner package 2. Alternatively, the mat may be positioned closer to one side of the inner package 2, as shown in Fig. 4. As shown in Fig. 5, a plurality of mats 1a, 1a, . . . may be placed at given spacings within a single inner bag 2a which is heat-sealed in the areas surrounding the individual mats to form a sealed area 3a. The pest control sheet shown in Fig. 5 may be immediately put to use after removal from the outer package or container. Alternatively, the inner package may be perforated in the sealed area surrounding one or more mats so as to facilitate a detachment of the packaged mats as a unit before use.

The inner package may be sealed in the areas that surround a mat or mats, as shown in Figs. 1, 4, 5 and 6. Alternatively, the inner package 2c may be sealed only on its four sides, as shown in Fig. 7, thereby permitting free movement of a plurality of mats 1c, 1c within the package. In another embodiment, sealed areas 3d may be interrupted by an unsealed area 4, as shown in Fig. 8. Two mats 1e and 1f having different thicknesses may be placed within the same inner package 2e, as shown in Fig. 9. Alternatively, a smaller mat 1g and a larger mat 1h may be placed within the same inner package 2f. If desired, the inner package 2g (Fig. 11) or 2h (Fig. 12) may be provided with one or more holes 5a (Fig. 11) or 5b (Fig. 12) in predetermined areas (usually in the areas where the mat 1i or 1j is packaged).

As described in the foregoing pages, the pest control sheet according to the present invention comprises a substrate of a given thickness that retains a liquid pest control agent (including an insecticide, moth proofing fragrance or repellant) and which is accommodated in an inner package in such a manner that the surface area of the substrate occupies a specified proportion of the total surface area of the inner

package. Because of this arrangement, the effective component in the substrate is transferred rapidly into the inner package which is in contact with said substrate, and thereafter, the inner package which now serves as the second element for impregnation with the effective ingredient lets a constant amount of this ingredient evaporated from its surface. The resulting loss in the amount of the effective ingredient in the inner package is compensated by an additional supply from the substrate, and this ensures continued evaporation of the effective component.

When the pest control sheet of the present invention is taken out of the outer package or container, a relatively large amount of the effective ingredient is transferred from the substrate to the inner package of a greater surface area and evaporates rapidly from this inner package into the target space, thus ensuring the evaporation of a sufficient amount of the effective ingredient in the initial stage of use. In the subsequent stages, the sheet permits the effective ingredient to be supplied to the inner package in a constant amount, being little influenced by fluctuations in the environment. Furthermore, the supply (transfer) of the effective ingredient to the inner package is the rate-determining step of the process of supply and evaporation of the ingredient. Therefore, by properly controlling the amount of the ingredient supplied, excessive evaporation is prevented and the intended pest control effect is maintained over an extended period. The amount of the effective ingredient being supplied can be readily controlled by changing the number of the substrates and the amount of the ingredient initially impregnated in each substrate. Needless to say, the function of the inner package used in the present invention is not limited to the use as an evaporation medium. It also fulfills its usual functions as a means for protecting the substrate and for preventing the fouling of clothes by avoiding their direct contact with the substrate (the effective ingredeint is also impregnated in the inner package, but the amount of its transfer is not great enough to foul clothes). Another function of the inner package is to increase the aesthetic appeal of the pest control sheet, and hence its commercial value.

The pest control sheet of the present invention also has advantages from the viewpoint of manufacture. The amount of a liquid pest control agent necessary for exhibiting its efficacy is usually very small, and with the conventional large sized substrate or complexly shaped substrate having a large surface area, it is very difficult to apply a metered amount of the effective ingredient uniformly to the entire surface of the substrate by a simple method. As a result, less simple techniques such as simultaneous dropping of a solution through a plurality of nozzles, immersion in solvents and coating by a printing machine are necessary, and coupled with the limited number of the materials available for making the substrate, these involve great difficulty in selecting the proper manufacturing process and its scale, as well as in handling the in-process products. However, the pest control sheet of the present invention uses a smaller substrate than does the conventional product, so irrespective of the necessary amount of the effective ingredient, it need only be applied to one or more points on the substrate. Furthermore, the overall size and surface area of the substrate are small enough to achieve sufficient and uniform impregnation of the effective ingredient throughout the substrate. The coating method is simple and permits easy application of a metered amount of the effective ingredient. Large substrates are inconvenient to handle during transport and use. However, the pest control sheet of the present invention has its substrate wrapped with an inner package and can be folded into a compact size which is not bulky and can be put into a small, and hence inexpensive, outer package or container. The folded sheet may simply be unfolded must before use.

According to the second aspect of the present invention, there is provided a device for indicating the termination of the effectiveness of the pest control sheet and other evaporative agents in packages. This device is hereunder described by showing its advantages over the conventional product.

Figs. 13 to 15 show the conventional device for indicating the termination of the effectiveness of the pest control sheet. The device consists of twelve perforated portions 13 (the performation is indicated by 12) provided on one lateral side of a sheet. These perforated portions are designed to indicate "Month Started" by a series of months starting with January and ending with December. Adjacent to the column of these perforated sections, there is provided a column of months starting with July and ending with June for indicating "Month for Replacement". When the pest control sheet is first used in January, the user detaches the performated portion marked "January" and recognizes that he has to replace the sheet in July. However, with this conventional device marked with two parallel adjacent columns of "Month Started" and "Month for Replacement" on the same side of the sheet, the user often reads a month wrongly or finds considerable difficulty in understanding how to use that device. Furthermore, if the user detaches a perforated portion wrongly, he is no longer able to replace it. Another defect is that the perforated portions are too small to handle conveniently.

These disadvantages are absent from the device of the present invention which consists of a single sheet folded into inner and outer layers, the latter layer being provided with a cut and perforation to form at least one portion that can be peeled away above the fold line. The device according to the present invention for indicating the termination of the effectiveness of a pest control sheet is hereunder described in detail by reference to Figs. 16 to 22. In Fig. 16, the symbol A indicates the pest control sheet according to the first aspect of the present invention. This pest control sheet has a plurality of mats 21 as substrates wrapped with a package in a sheet form 22, the mats having been impregnated with, for example, a liquid pest control agent. The top and bottom of the sheet 22 are respectively provided with supports 23 and 24 made of a sheet material such as paperboard. The support 23 at the top is provided with a hook 25. Referring to Figs. 17 and 18, the support 24 at the bottom of the package sheet 22 consists of a single printable sheet 20 that has been folded into two layers which are securely fixed to the package sheet 22. The outer layer 26 of

the folded sheet 20 has four cut portions 28a, 28b, 28c and 28d. Two perforations 30a and 30a' extend from both ends of the cut portion 28a to reach the fold line 29. Likewise, three pairs of perforations (30b and 30b'), (30c and 30c') and (30d and 30d') extend from the cut portions 28b, 28c and 28d, respectively. The combinations of these cut portions and perforations form four peelable sections 31, 32, 33 and 34 which are respectively marked with "starting times" such as "spring", "summer", "autumn" and "winter". The back sides of the peelable sections 31 to 34, in combination with those parts of the inner layer 27 which correspond to these peelable sections, form indicating sections 35 to 38. These sections 35 to 38 are marked with "replacement times" such as "autumn", "winter", "spring" and "summer" corresponding to the "spring", "summer", "autumn" and "winter" marked as "starting times" on the peelable portions 31 to 34. If desired, the sections 35 to 38 may also be marked with pictures such as those of flowers that symbolize the respective replacement times, as well as with words such as "Replace in" which appear before each replacement time.

If the pest control sheet is first used in spring, the user may hold the cut portion 28a with the fingers and peel it away along the perforations 30a and 30a', thereby exposing the word "autumn" marked on the indicating section 35. By seeing this word, the user recognizes that he has to replace the pest control sheet in autumn.

It should be understood that the device according to the present invention may be provided on the support 23 at the top of the package sheet 20 rather than on the support 24 at the bottom.

Another embodiment of the device according to the present invention is shown in Figs. 19 and 20. A folded sheet 20 is attached to either the upper support 23 or lower support 24 on the pest control sheet A. The outer layer 26 of the sheet 20 has three vertical cuts 40 that extend to the fold line and which are provided at given spacings in the transversal direction. The upper part of the outer layer 26 is provided with a horizontal performation 41 that spans the two lateral sides of the sheet 20 crossing the three vertical cut lines 40, to thereby form four peelable portions 31 to 34. These portions are marked with "starting times" such as "spring", "summer", "autumn" and "winter". The back sides of these peelable portions as combined with the corresponding indicating sections 35 to 38 of the inner layer 27 are marked with "replacement times" such as "autumn", "winter", "spring" and "summer", preferably with the words "Replace in" put before these replacement time indications. If the pest control sheet is first used in spring, the user tears the section 31 along the perforation 41, causing the flap 31 to hang down to expose the indication "autumn".

Still another embodiment of the indicating device of the present invention is shown in Figs. 21 and 22. A square sheet 20 is folded on four sides to leave a square unfolded portion 43 in the center, and the two overlapping outer layers at each corner are bonded together. The folded sheet is provided with perforations 45 that extend from each side of the unfolded square portion 43 to the four fold lines 29, to thereby form peelable sections 31 to 34. These sections are marked with "starting times" such as "spring", "summer", "autumn" and "winter". The back sides of the respective peelable sections in combination with the corresponding portions of the inner layer 27 form indicating sections 35 to 38 marked with "replacement times" such as "autumn", "winter", "spring" and "summer", preferably with the words "Replace in" put before these replacement time indications. The unfolded portion 43 is provided with a pin 46 in its center that is inserted either into the upper support 23 or into lower support 24 on the pest control sheet A so as to attach the sheet 20 rotatably to the sheet A. The user rotates the sheet 20 to a position that enables him to read a specific starting time, say, "spring". The, he tears the peelable section 31 along the perforations 45 with the fingers and lets that section hang down to expose the indication "autumn".

In the three embodiments of the indicating device of the present invention shown above, the numbers of the peelable sections and indicating sections are four respectively. However, as will be readily understood by those skilled in the art, the number of these sections may be adjusted depending upon the effective period of the pest control agent used.

Furthermore, the three embodiments described above concern the application of the device to the pest control sheet (which is the first aspect of the present invention) comprising a package sheet that wraps mats impregnated with a liquid pest control agent. However, it should be understood that the device can also be used to indicate the termination of the effectiveness of other various packaged products such as liquid or solid evaporative agents including pest control agents, insecticides, fragrances, deodorants, repellants, attractants and bactericides which are placed in plastic containers or wrapped with paper or non-woven fabrics. Therefore, the term "packaged products of evaporative agents" as used in this specifiction should be taken to mean all types of products having liquid or solid evaporative agents placed in a container or wrapped with paper or nonwoven fabrics.

As described in the foregoing pages, the device according to the present invention for indicating the termination of the effectiveness of packaged products of evaporative agents comprises a single sheet which is folded into outer and inner layers, the former layer being provided with at least one peelable portion that is marked with a "starting time" and which can be peeled away above the fold line, that part of the inner layer which corresponds to that peelable section being marked with a "replacement time". With the conventional type of this device, two parallel adjacent columns for indicating "starting times" and "replacement times" are marked on the same side of the sheet, and the user often fails to read a time correctly, or finds much difficulty in understanding how to use the device. These troubles are entirely absent from the device of the present invention which marks only the "starting time" on its outer surface.

As a further advantage, the peelable sections 31 to 34 formed on the device are easily peelable and the user can check the correct "replacement time" by simply peeling away one of these sections. Even if he peels away a wrong section, he can readily replace it by attaching it to the outer layer 26 of the sheet 20 with adhesive tape.

The advantages of the pest control sheet according to the present invention are hereunder described in greater detail by reference to working examples and comparative examples, which are also intended to show the criticality of the specified proportion of the surface area of the mat or mats impregnated with a pest control agent to the total surface area of the inner package by which said mats are wrapped.

Examples 1 to 5 and Comparative Examples 1 to 4

A pulp mat 2 mm thick having the size shown in Table 1 below was impregnated with 600 mg of Vaporthrin. The mat was then put into a rectangular package of nonwoven fabrics (33 cm×8 cm) which has been heat-sealed along three sides. After heat-sealing the remaining side, the sheet package containing the mat impregnated with Vaporthrin was hung in a wardrobe (capacity: ca. 750 liters). Another sample of the pest control sheet was prepared in the same manner and hung in the wardrobe. A wire mesh ball containing 10 larvae of clothes moth and a piece of wool mousseline (2 cm×2 cm) were also put in the wardrobe. The same procedure was repeated in Examples 2 to 5 and Comparative Examples 1 to 4. The mat sizes shown in Table 1 are indicated in terms of area factor, or the proportion of the surface area of each mat to the total surface area of the sheet package.

TABLE 1

Sample No.	Mat size (area factor)
Ex. 1	5%
Ex. 2	10%
Ex. 3	20%
Ex. 4	40%
Ex. 5	55%
Comp. Ex. 1	2%
Comp. Ex. 2	20% (without nonwoven fabric package)
Comp. Ex. 3	80%
Comp. Ex. 4	80% (without nonwoven fabric package)

The efficacy of each pest control sheet was evaluated in terms of the percent damage inhibition as calculated by the following formula:

$$\text{Percent damage inhibition} = 100 - \frac{A-B}{A} \times 100$$

wherein A stands for the initial weight of mousseline (mg) and B stands for the weight of the mousseline damaged by the clothes moth (mg).

The test results are shown in Figs. 23 to 25. As is clear from Fig. 23, comparative sample No. 1 using a very small mat whose surface area was only 2% of the total surface area of the sheet package was unable to exhibit sufficient efficacy because of the smallness of the amount of the effective ingredient that was transferred from the mat into the sheet package. As is clear from Fig. 24, comparative sample No. 2 which used a sufficiently large mat but which did not wrap it with a sheet package also proved ineffectual. Comparative samples Nos. 3 and 4 used mats having an area factor of 80%, and comparative sample No. 3 using the mat in a package retained its effectiveness for a longer period than comparative sample No. 4 (using an unpackaged mat) because the former had the ability to control the evaporation of the effective ingredient by means of transfer from the mat into the package. However, both comparative samples were inferior to the samples of the present invention and had an excessively high evaporation of the active ingredient because the area factor of the mat used was higher than 60% of the total surface area of the sheet package.

The above results show that in order to achieve the purpose of the present invention, the proportion of the surface area of impregnated mat to the total surface area of the inner package must be within the range of 5 to 60%. Best results were obtained when the area factor was in the range of 5 to 40%.

Examples 6 to 9 and Comparative Examples 5 and 6

A pest damage inhibition test was conducted by repeating the procedure of Example 1 except that pulp mats (8 cm×7 cm) having the various thicknesses shown in Table 2 were used.

TABLE 2

Sample No.	Mat thickness (mm)
Ex. 6	1
Ex. 7	2.5
Ex. 8	5.0
Ex. 9	10.0
Comp. Ex. 5	0.5
Comp. Ex. 6	15.0

The test results are shown in Figs. 26 and 27 in terms of percent damage inhibition defined in Example 1. As is clear from Fig. 26, comparative sample No. 5 using a very thin mat (0.5 mm) remained effective for only a short period because it was unable to control the rapid transfer of the active ingredient into the nonwoven fabric sheet. Comparative sample No. 6 using a very thick mat (15 mm) was also ineffective but this time, the reason was the excessively high ability of the mat to retain the active ingredient that prevented its sufficient penetration into the sheet package.

The above results show that the preferred thickness of the substrate impregnated with the active ingredient according to the present invention is in the range of 1 to 10 mm, with best results being obtained by the range of 2 to 10 mm.

Example 10

A pulp mat (5 cm×4 cm×2.5 mm) was impregnated with 600 mg of Vaporthrin and wrapped with a nonwoven fabric sheet package (33 cm×8 cm). Two more pest control sheet samples were prepared in the same manner; one of them contained three impregnated mats, and the other contained five mats. For each sample, the total amount of the effective ingredient Vaporthrin was the same (600 mg). The three samples thus prepared were hung together in the same wardrobe (capacity: ca. 750 liters). For each sample, a set of two control sheets was subject to the experiment. The amount of the effective ingredient remaining in the pest control sheet was analyzed after elapsing a predetermined period of time. The same experiment and analysis were repeated every test period of time. The results are shown in Fig. 28, from which one can see that the amount of evaporation of the effective ingredient, namely its transfer from the mat into the sheet package, can be controlled by changing the number of the mats to be wrapped with the sheet package.

Examples 11 to 13 and Comparative Examples 7 to 10

A pulp mat 2 mm thick having the size shown in Table 3 below was impregnated with 500 mg of N,N-diethyl-m-toluamide (repellant). The mat was then put into a rectangular package of nonwoven fabrics (33 cm×8 cm) which had been heat-sealed on three sides. After heat-sealing the remaining side, the sheet package containing the mat impregnated with N,N-diethyl-m-toluamide was hung in a veneer-made box (capacity: ca. 750 liters) having a double-leaf hinged door with a clearance of 1 mm from the base plate of the box. Another sample of the repellant sheet was prepared in the same manner and hung in the same box. Ten pieces of clothes made of wool were placed in the box together with 40 larvae of clothes moth. After elapsing a predetermined period of time, the number of larvae that came out of the box was counted. The same procedure was repeated every test period of time, and in Examples 12 and 13, as well as Comparative Examples 7 to 9. In Comparative Example 10, no repellent sheet was used and the clothes moth larvae were simply put in the box together with the clothes.

TABLE 3

Sample No.	Mat size (area factor)
Ex. 11	5%
Ex. 12	20%
Ex. 13	55%
Comp. Ex. 7	2%
Comp. Ex. 8	20% (without nonwoven fabric package)
Comp. Ex. 9	80%
Comp. Ex. 10	—

The test results are shown in Figs. 29 and 30, from which one can see that in order to achieve the desired repelling effect, the substrate impregnated with the active ingredient must have a surface area which is 5 to 60% of the total surface area of the sheet package.

Examples 14 to 16 and Comparative Examples 11 to 13

A pulp mat 2 mm thick having the size shown in Table 4 below was impregnated with 1 g of citronellol (moth proofing fragrance). The mat was then put into a rectangular package of nonwoven fabrics (33 cm×8 cm) which had been heat-sealed on three sides. After heat-sealing the remaining side, the sheet package containing the mat impregnated with citronellol was hung in a wardrobe (capacity: ca. 750 liters). Another sample of the pest control sheet was prepared in the same manner and hung in the wardrobe. A wire mesh ball containing 10 larvae of clothes moth and a piece of wool mousseline (2 cm×2 cm) were also put in the wardrobe. The same procedure was repeated in Examples 15 and 16 and in Comparative Examples 11 and 13.

TABLE 4

Sample No.	Mat size (area factor)
Ex. 14	5%
Ex. 15	20%
Ex. 16	55%
Comp. Ex. 11	2%
Comp. Ex. 12	20% (without nonwoven fabric package)
Comp. Ex. 13	80%

The test results are shown in Figs. 31 and 32, from which one can see that in order to achieve the desired pest control effect, the substrate impregnated with the active ingredient must have a surface area which is 5 to 60% of the total surface area of the sheet package.

CLAIMS

1. A pest control sheet having at least one substrate wrapped with a package in a thin sheet form in such a manner that the surface area of said substrate is 5 to 60% of the total surface area of said package, said substrate having a thickness of 1 to 10 mm and having been impregnated with a liquid pest control agent (including an insecticide, moth proofing fragrance or repellant), said package being made of a gas-permeable sheet material having a good desorbing ability.

2. A pest control sheet according to Claim 1 wherein said liquid pest control agent is a liquid evaporative insecticide which is selected from 1-ethynyl-2-methyl-2-pentenyl-2,2-dimethyl-3-(2',2'-dichlorovinyl)-cyclopropane-1-carboxylate, 1-ethynyl-2-methyl-2-pentenyl-2,2-dimethyl-3-(2'-methyl-1'-propenyl)-cyclopropane-1-carboxylate and 1-ethynyl-2-methyl-2-pentenyl-2,2,3,3,-tetramethylcyclopropane carboxylate.

3. A pest control sheet according to Claim 1 wherein said liquid pest control agent is a liquid repellant which is selected from N,N-diethyl-m-toluamide, 2,3,4,5-bis(2-butylene)-tetrahydrofurfural, di-n-propyl isocinchomeronate and dibutyl phthalate.

4. A pest control sheet according to Claim 1 wherein said liquid pest control agent is a liquid moth proofing fragrance which is selected from citronellol, eugenol and isosafrol.

5. A pest control sheet according to Claim 1 wherein said substrate is made of a material selected from among natural fibers, synthetic fibers, inorganic fibers, plastics, inorganic porous materials, gelling agents and compounds capable of including a liquid pest control agent therein, and combinations thereof.

6. A pest control sheet according to Claim 1 wherein said substrate is in the form of paper, film, sheet, plate, woven or nonwoven fabric or a mat.

7. A pest control sheet according to Claim 1 wherein said substrate is a microencapsulated liquid pest control agent.

8. A pest control sheet according to Claim 1 wherein said substrate has a thickness of 2 to 10 mm.

9. A pest control sheet according to Claim 1 wherein said substrate has a surface area which occupies 5 to 40% of the total surface area of said package made of a gas-permeable sheet material having good desorbing ability.

10. A pest control sheet according to Claim 1 wherein said gas-permeable sheet is made of paper, woven or nonwoven fabric.

11. A pest control sheet according to Claim 1 wherein said gas-permeable sheet material is heat-fusible.

12. A pest control sheet according to Claim 1 wherein said package is made of a gas-permeable heat-fusible sheet material, a plurality of substrates being arranged adjacent, but not in mutual contact, within said package, the two sheets of the package being heat-sealed in the area defined between two adjacent substrates.

13. A product having the pest control sheet according to any of Claims 1 to 12 confined and sealed in a container which is made of a gas-impermeable material.

14. A product according to Claim 13 wherein said container is made of a gas-impermeable sheet material.

15. A product according to Claim 14 wherein said gas-impermeable sheet material is selected from an aluminum foil, a laminate having an aluminum layer and a plastic sheet deposited with aluminum.

16. A product according to Claim 13 wherein said container is a plastic can.

17. A device for indicating the termination of the effectiveness of a packaged product of an evaporative agent, which comprises a single printable sheet having at least one predetermined region marked with an indication of "replacement time", said sheet being folded up to form outer and inner layers in such a manner that said indicating region is concealed and that part of the sheet which has said indicating region forms the inner layer, that part of the outer layer of the folded sheet which corresponds to said indicating region forming a peelable section marked with a "starting time" that can be peeled away above the fold line, said outer and inner layers being rendered inseparable either by being bonded together at their upper edge or by being attached as a whole to said packaged product.

18. A device according to Claim 17 wherein said peelable section is defined by an upwardly convex cut and two perforations, said cut being made in said outer layer of the folded sheet at a predetermined distance from the fold line, said perforations being perpendicular to said fold line and extending from both ends of said cut up to the fold line.

19. A device according to Claim 17 wherein said outer layer of the folded sheet has a perforation spaced parallel to and at a given distance from the fold line and which runs across said outer layer, and at least one cut that is made in said outer layer and which extends from said perforation to said fold line in a direction perpendicular to said fold line, each of the peelable sections formed on both ends of the outer layer being defined by each lateral side of the outer layer, said perforation and said cut, provided that when a plurality of cuts are made, the peelable sections other than those formed on both ends of the outer layer are each defined by said perforation and two cuts.

20. A device according to Claim 17 wherein said sheet has a square form, said sheet being folded on four sides to leave a square unfolded portion in the center, the two overlapping outer layers at each corner being bonded together, the folded sheet being provided with perforations that extend from each side of the unfolded square portion to the four fold lines in a direction perpendicular to said fold lines, thereby forming peelable sections each defined by two of said perforations and the lateral edge of the outer layer forming one of the four sides of said unfolded portion.

21. A device according to Claim 17 wherein said packaged product is a pest control sheet according to any of Claims 1 to 12.

Amendments to the Claims have been Filed, and have the Following Effect:—
(b) New or Textually Amended Claims have been Filed as Follows:—

3. A pest control sheet according to Claim 1 wherein said liquid pest control agent is a liquid repellant which is selected from N,N-diethyl-m-toluamide, 2,3,4,5-bis (Δ^2-butylene)-tetrahydrofurfural, di-n-propyl isocinchomeronate and dibutyl phthalate.

5. A pest control sheet according to Claim 1 wherein said substrate is made of a material selected from among natural fibers, synthetic fibers, inorganic fibers, plastic film, inorganic porous materials, gelling agents and compounds capable of including a liquid pest control agent therein, and combinations thereof.

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